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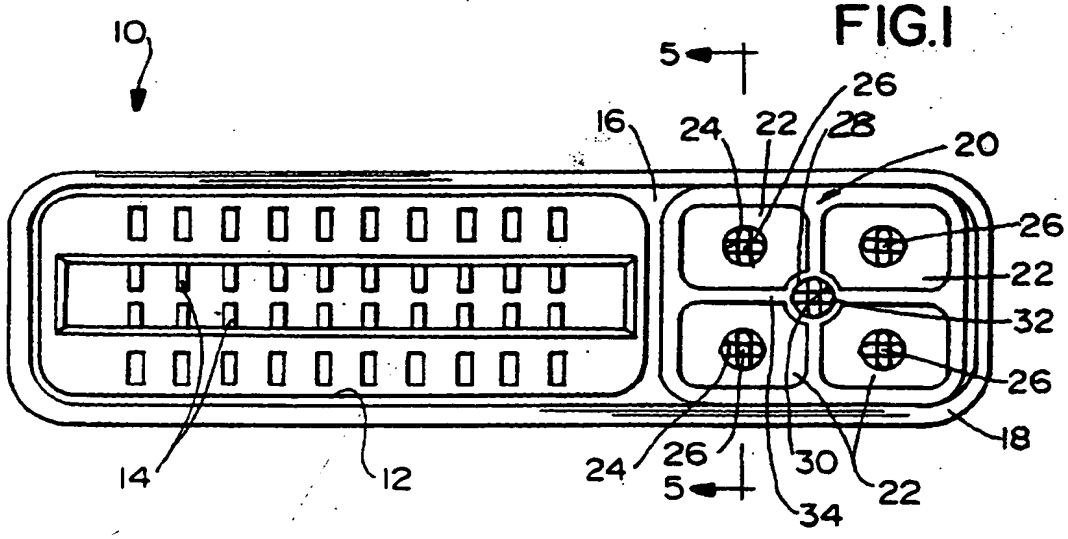
(54) **Electrical connector assembly.**

(57) An electrical connector assembly including a male connector and a female connector (10, 10', 10") each comprising groups of terminals, among them high frequency terminals (26). Ground terminal means (20, 20') is provided for shielding the high frequency terminals in the mating condition of the connectors.

FIG.1



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This invention relates to an electrical connector assembly of the preamble to claim 1 and, particularly, to a hybrid electrical connector for accommodating both high frequency transmission as well as lower frequency transmissions.

Electrical connectors are used to interconnect signal transmission lines to printed circuit boards, other electronic devices or to other complementary connectors. The transmission lines transmit signals through a plurality of conductors which, preferably, are physically separated and electromagnetically isolated along their length.

In the electronics industry, particularly the computer industry, the predominant system embodies a plurality of plug-in type connectors in mating engagement with receptacle connectors on the computer, its main printed circuit board or other electronic devices. The transmission lines typically include coaxial electrical cables, either in round or flat form, and round cables are presently being used predominantly in relatively high frequency applications between various system components.

Classical coaxial designs derive their characteristic impedance from the geometrical relationship between the inner signal conductors and the outer shield member and the intervening dielectric constant. For a given impedance, signal conductor size and dielectric material, an overall outside dimension is defined. In order to increase signal density and reduce the overall outside dimensions of a transmission line connector system, alternate geometries and/or dielectric materials are required. For data processing purposes, cables usually utilize twisted pairs of conductors to achieve the necessary characteristics, particularly impedance control and cross talk control. Coaxial cables are used in singular conductor configurations in high frequency applications, such as to a high-speed video monitor. Most often, the lower speed data transmission lines are separated from the high speed signal transmission lines. Consequently, different electrical connectors are often used for the lower speed data transmission lines than for the high speed signal lines. This adds to the problem of requiring multiple connectors in ever-increasing miniaturized and high density application.

An electrical connector according to the preamble of claim 1 is already known from US-A-4,846,711 wherein the second terminals are formed by three coaxial connectors arranged side by side, each having an axial cylindrical shell and a conductor center contact. Such an arrangement however consumes a considerable amount of space and requires separate terminations.

This invention is directed to solving such space problems by providing an electrical connector assembly which terminates both high speed signal transmission lines and the slower data transmission lines in a unique manner providing a common ground for the signal transmission lines.

An object, therefore, of the invention is to provide a new and improved system, as well as an electrical connector assembly, for interconnecting signal transmission lines in electronic devices, such as computers or the like.

The invention is defined in claim 1.

According to an aspect of the invention, an electrical connector is provided as an interface between a plurality of high speed transmission lines and such lines of an electronic device, particularly a printed circuit board of the device. The connector assembly includes a common ground system for all of the high frequency conductors to reduce the number of interconnections predominant in the prior art and to increase signal density while maintaining a desired impedance level. As disclosed herein, the interconnection with the high frequency conductors is combined with terminals for interconnection to a plurality of slower data transmission lines to create a matrix-type hybrid connector assembly.

Other objects, features and advantages of the invention will be apparent from the following detailed description taken in connection with the accompanying drawings.

The features of this invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with its objects and the advantages thereof, may be best understood by reference to the following description taken in conjunction with the accompanying drawings, in which like reference numerals identify like elements in the figures and in which

- Fig. 1 is a front elevational view of a female connector;
- Fig. 2 is a perspective view of the insulators used in the connector of Fig. 1;
- Fig. 3 is a vertical section through one of the insulators shown in Fig. 2, namely the bottom right-hand insulator of Fig. 3;
- Fig. 4 is a perspective view similar to that of Fig. 3, with a contact loaded into the insulator;
- Fig. 5 is a vertical section taken generally along line 5-5 of Fig. 1;
- Fig. 6 is a fragmented elevational view of second embodiment of the female connector;
- Fig. 7 is a perspective view of the housing utilized in Fig. 6;
- Fig. 8 is a perspective view of a tail aligner that could be utilized with the housing of Fig. 7 or the connector of Fig. 1;

Fig. 9 is a perspective view of a ground member utilized in Fig. 6;

Fig. 10 is a perspective view showing a third embodiment of the female connector; and

Fig. 11 is an elevated view of a fourth embodiment of the female connector.

Referring to the drawings in greater detail and at first to Fig. 1, the invention contemplates a hybrid electrical connector assembly that terminates both the conductors for data transmission lines and the conductors of high frequency transmission lines. More particularly, female electrical connector 10 includes a receptacle portion 12 having contact portions 14 of a plurality of terminals mounted therein exposed for engagement with appropriate contacts of a complementary mating male or plug-in connector. The left-hand portion or section of the electrical connector 10 shown in Fig. 1 forms a standard data connector. However, the right-hand portion or section of connector 10 provides a high frequency connector.

Still referring to Fig. 1, connector 10 includes a dielectric housing 16 surrounded by a conductive shield 18 which spans substantially the entire length of the connector. A single or common ground member 20 of die-cast metal material, or the like, surrounds four quadrants which are filled by separate insulator members 22. Each insulator member 22 has a passage 24 for receiving signal contacts or terminals 26. Such passage 24 can be positioned within insulator 22 and with respect to ground member 20 in order to provide controlled impedance. Ground member 20 has a central circular portion 28 surrounding a passage 30 for receiving a ground contact or terminal 32. Ground member 20 is shaped to have spokes or webs 34 dividing the interior of the ground member into the quadrants. Therefore, it can be seen in Fig. 1 that all of signals contacts 26 and ground contact 32 are surrounded by the single ground member 20. This is in striking contrast to prior systems wherein typical coaxial interface designs use separate or discrete ground connections which consume a considerable amount of space and require separate terminations. With the single ground member 20 surrounding all of the contacts, a common ground plane is provided to control impedance, emissions of radiation and cross talk between the contacts of the connector assembly.

Fig. 2 shows all four insulators 22 in a perspective depiction as they are located within ground member 20. Fig. 3 shows a section through one of the insulators 22 to illustrate the configuration of passage 24 therethrough. It can be seen that the passage has an entry end 40 for receiving a contact of the complementary mate connector, a back wall 42, a through passage portion 44 and a shoulder 46. With the above-described configuration of the interior passages of each insulator 22 in relation to Fig. 3, reference is made to Figs. 4 and 5 wherein a signal contact, generally designated 26, is shown positioned in passages 24. Each contact 26 includes a contact end 50 and a solder tail end 52. The contact end 50 is disposed in passage 24 and the solder tail 52 is provided for interconnection to a circuit trace on a printed circuit board as is known in the art. Contact end 50 is fabricated by a plurality of contact spring arms which are "crowned" for the complementary male connector.

Each contact 26 is securely locked into position within its respective insulator 22 by means of a base portion 54 of the contact engaging back wall 42 of the insulator, and the base portion is provided with a locking barb 56 for snapping behind shoulder 46 of its insulator. In assembly of contacts 26 into insulator 22, solder tail portion 52 initially extends parallel to the axis of the contact end 50 so that the contacts can be loaded into insulators 22 in the direction of arrows "A" in Figure 5. When base portions 54 of the contacts engage back walls 42 of the insulators, locking barbs 56 snap behind shoulders 44 of the insulators. Solder tails 52 then are bent downwardly as shown in Figures 4 and 5.

Figure 5 also shows the positioning of shield 18 and how it surrounds housing 16 and common ground member 20. Shield 18 includes locking projections 59 which extend through openings in the dielectric housing 16, in the ground member 20 and in the back cover shielding member 64 to be engaged in openings similar to those (60) in Figure 7 in the dielectric housing 16'. The back cover shielding member 64 is made from a conductive material. These components are dimensioned so that the shield 18, ground member 20 and back cover 64 are mechanically and electrically secured to complete the ground circuit between them. Back cover 64 covers and shields the rear portion of the connector and the tail portions of the terminals.

Solder tail portions 52 are shown extending through passages in tail aligner 66. The solder tail portions 52 of the terminals 26, 32 have three different lengths. The longest solder tails are connected to the upper terminals 26 and extend through holes 68 in the tail aligner 66 (Figs. 5 and 8). The shortest solder tails are connected to the lower terminals 26 and extend through holes 70 in the tail aligner 66. The solder tail of ground terminal 32 has a length between those of the upper terminals and lower terminals and extend through hole 72 in the tail aligner 66. In order to compensate for the resulting difference in path lengths, the tail aligner (Figs. 5 and 8) may include stepped portion 67. The stepped tail aligner 66 is dimensioned so as to balance the impedance of each line to a desired value.

Fig. 6 shows an alternate form of the female connector in regard to the right-hand end or high frequency portion thereof. In Fig. 6, the connector is designated 10' and like numerals have been applied to designate like components in comparison to the embodiment of Figure 3. Similar but not identical components are designated with a " ' ".

More particularly, electrical connector 10' also includes a common ground member, generally designated 20' for surrounding ground contact 32 and electrically isolating contacts 26. Again, ground member 20' provides a common ground plane to control impedance, emissions of radiation and cross-talk between the contacts of the connector assembly. In this embodiment, it can be seen that the separate insulators 22 of the embodiment of Fig. 1 have been eliminated, and main dielectric housing 16' extends entirely about the signal contacts 26. A perspective view of the whole housing 16' is shown in Fig. 7. The housing has four passages 24' for receiving the signal contacts 26. The interior of the passages may be similar to the configuration of passages 24 (Fig. 3) in insulators 22. In the embodiment of Figure 6, common ground member 20' includes a central circular portion 28 (Fig. 9) surrounding ground contact 32, and four spoke portions 34 radiate outwardly from circular portion 28 between signal contacts 26. Openings 62 (Fig. 9) in member 20' serve for cooperating with locking projections of the outer shield 18 similar to projections 59 of the Figs. 1-5 embodiment. As seen in Figure 7, housing 16' has internal passage means 76 of a shape corresponding to the cross-section of the spoked portion of common ground member 20'. Although the ground member 20' in the embodiment of Figure 6 does not completely surround signal contacts 26 as does ground member 20 (Fig. 1), the ground member 20' is the closest conductor to each signal terminal 26 and therefore acts as the primary ground reference in order to control the impedance. It further isolates each of the signal contacts from the outer signal contacts. In addition, this embodiment has the advantage of using main housing 16' as the insulating means surrounding the signal contacts 26 which simplifies the assembly of the conductor.

It should be understood that in many applications, only three signal contacts 26 would be provided, such as the "red", "green" and "blue" signals to a video monitor. The passage in the fourth quadrant, for such applications, could be provided for other functions, such as a keying receptacle 80 (Fig. 10). Such passage could either be formed in the ground member 20' or in the dielectric housing 16'. A male plug (not shown) dimensioned to mate only with the keying receptacle is provided on the male connector that mates with female connector 10'.

Fig. 11 shows a further embodiment wherein the female electrical connector 10" (corresponding to connectors 10 and 10') has the three high frequency signal contacts 26 arranged in a vertically stacked array. Each contact is surrounded by a cylindrical insulator 82 which, in turn, is surrounded by a common conductive ground member 84 corresponding in function to the ground members 20 and 20' in the embodiments of Figs. 1 and 8, respectively. It can be seen that no separate ground contact (32 in Figs. 1 and 6) is incorporated in this embodiment.

It will be understood by those skilled in the art that connectors 10, 10' and 10" will be utilized with similarly configured male connectors which are not described herein.

It will further be understood that the invention may be embodied in other specific forms of the male and female connectors without departing from the spirit or central characteristics thereof as defined by the claims.

Claims

1. An electrical connector assembly including
a first connector with male terminals, and
a second connector with female terminals, said male and female terminals having mating portions,
each connector (10, 10', 10") having
a dielectric housing (16, 16'),
groups of terminals, one of the groups having at least three high frequency terminals (26), and
ground terminal means (20, 20') for shielding the high frequency terminals,
characterized in that
in the mating condition of said connectors, said ground terminal means (20, 20') forms at least a three quadrant circle which defines a central axis, and
in that said high frequency terminals (26) are equidistantly disposed from said central axis and around said at least three quadrant circle in close proximity to the ground terminal means (20, 20').

2. The connector assembly of claim 1,
wherein said ground terminal means (20, 20') comprise a
generally central circular portion (28).

3. The connector assembly of claim 2
wherein said generally central circular portion (28) further includes spokes (34) extending radially from the circular portion (28).

4. The connector assembly of claim 3, wherein said spokes (34) merge into a generally closed shape positioned about said central axis.

5. The connector assembly according to any of claims 1-4, wherein said high frequency terminals (26) are located in quadrants formed by portions of said ground terminal means (20, 20').

6. The connector assembly according to any of claims 1-5, wherein a ground contact (32) is coaxially arranged to said central axis.

7. The connector assembly of any of claims 4-7, wherein said housing (16') is formed with passage means (76) to accomodate said ground terminal means (20').

8. The connector assembly of any of claims 4-7, wherein said housing (16) is formed with a section to take up the ground terminal means (20) and quadrant isolators (22) which have passages (24) to accomodate said high frequency terminals (26).

9. The connector assembly according to any of claims 1-8, wherein said dielectric housing (16, 16') is surrounded by a conductive shield (18) which is electrically connected to said ground terminal means (20, 20').

10. The connector assembly according to any of claims 1-9, wherein the number of the high frequency terminals (26) is four.

FIG.1

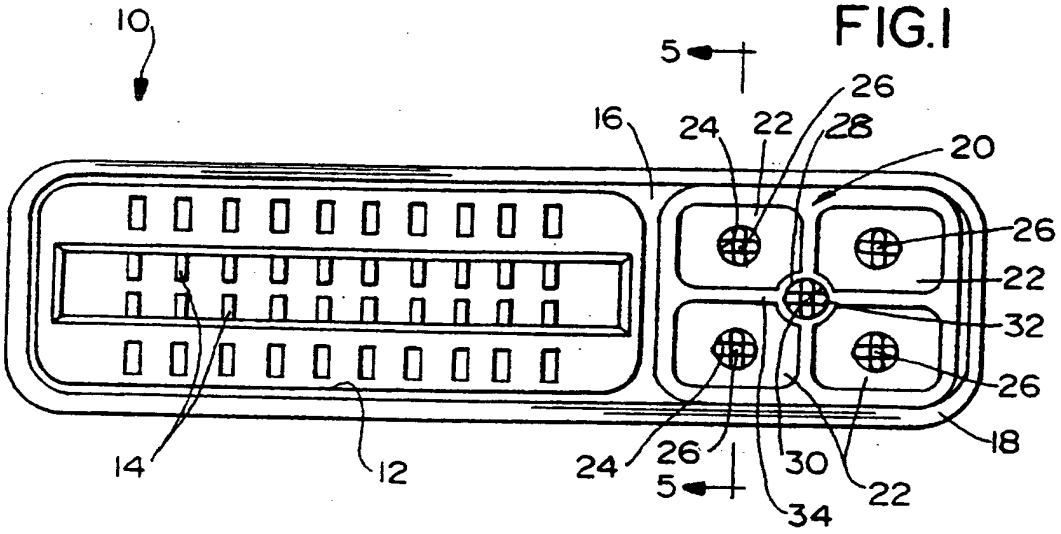
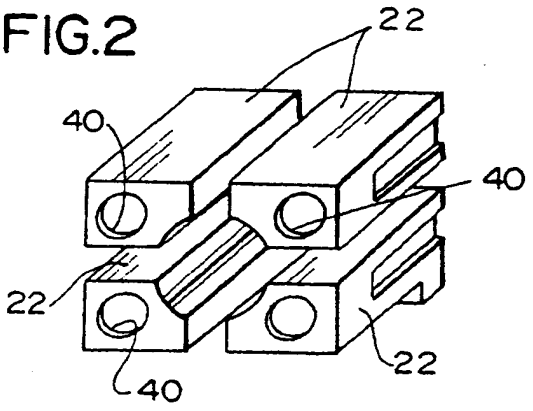


FIG.2



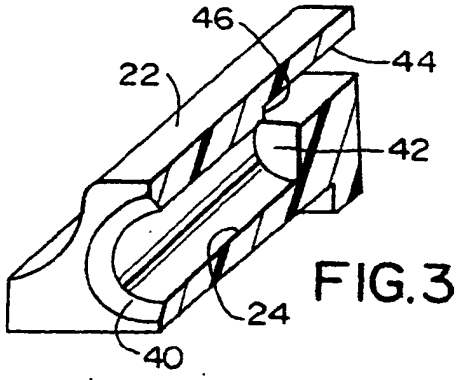


FIG.3

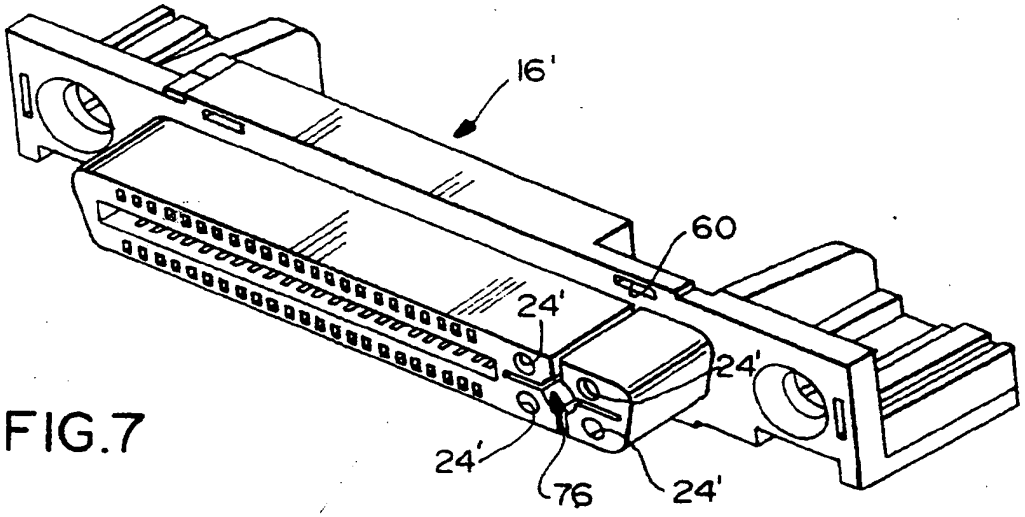
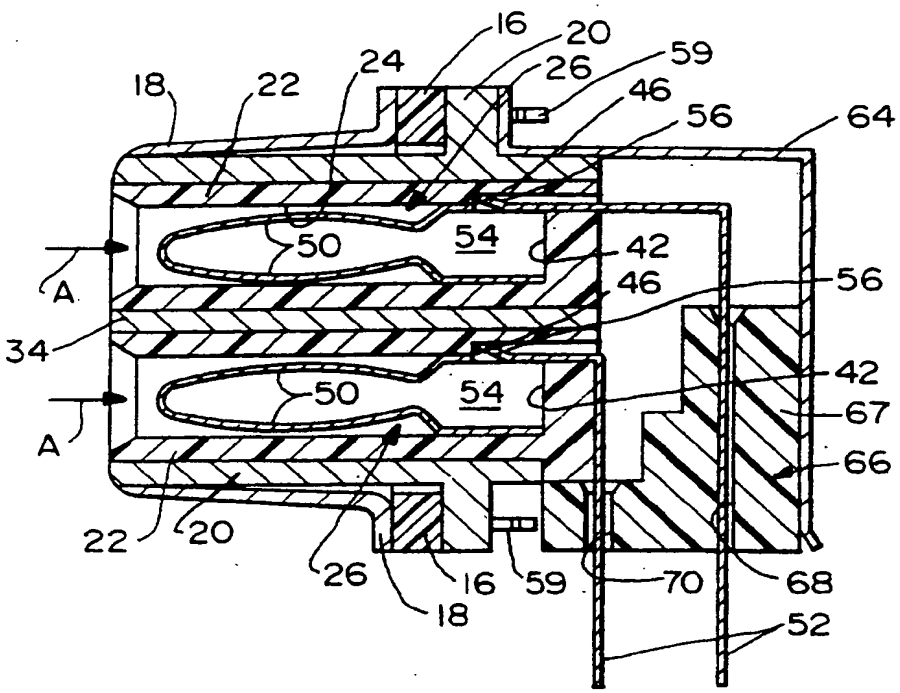


FIG.7

FIG.5



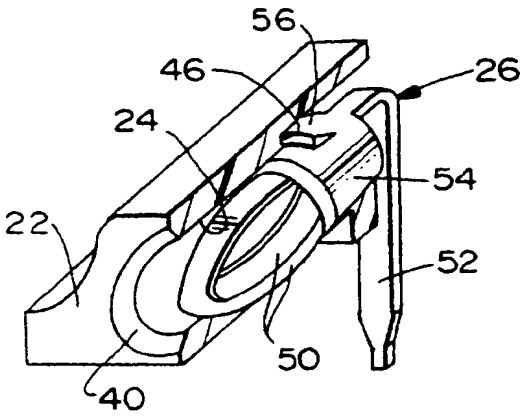


FIG.4

FIG.6

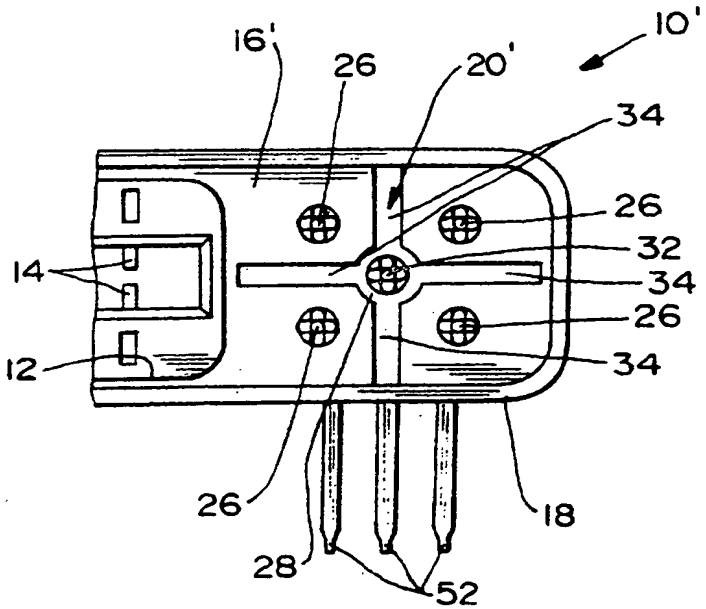
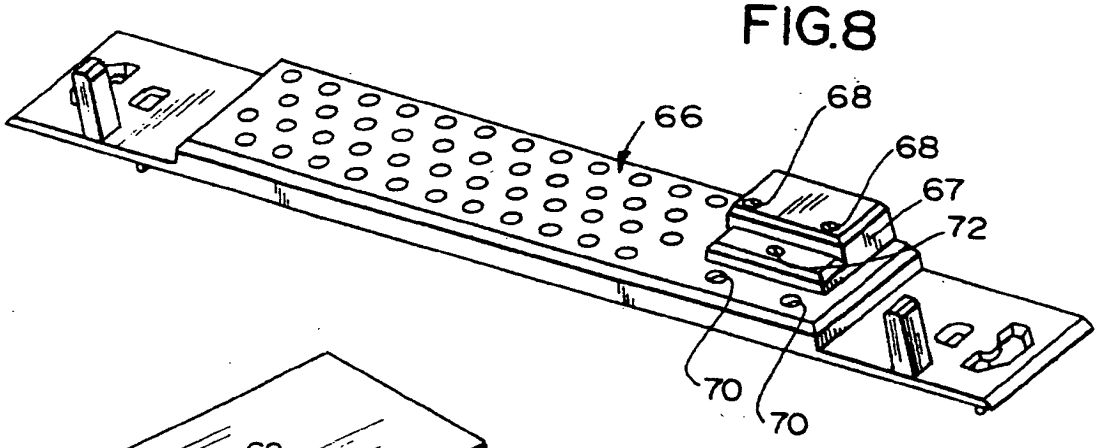


FIG.8



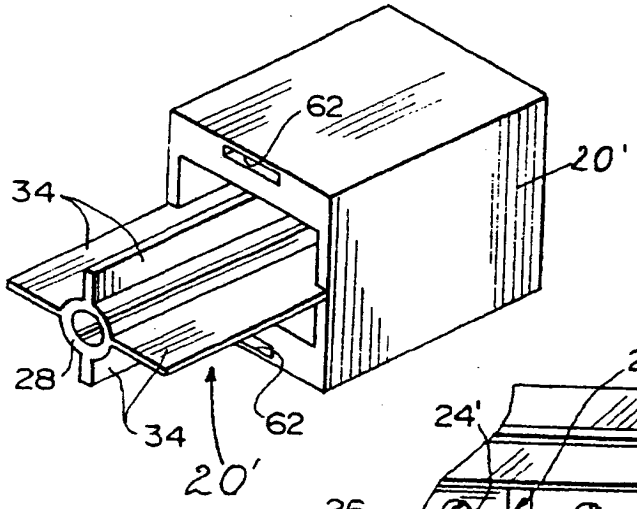


FIG.9

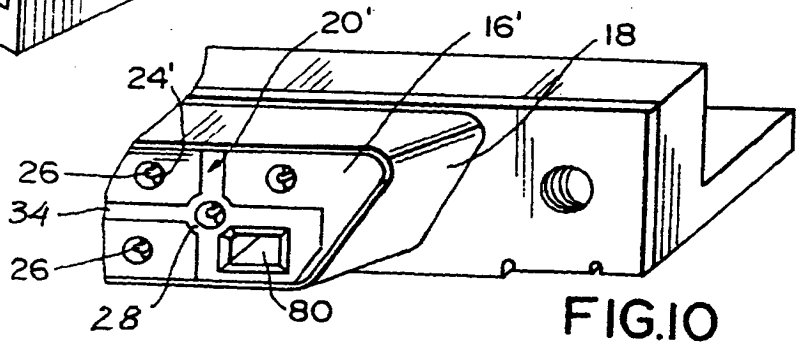


FIG.10

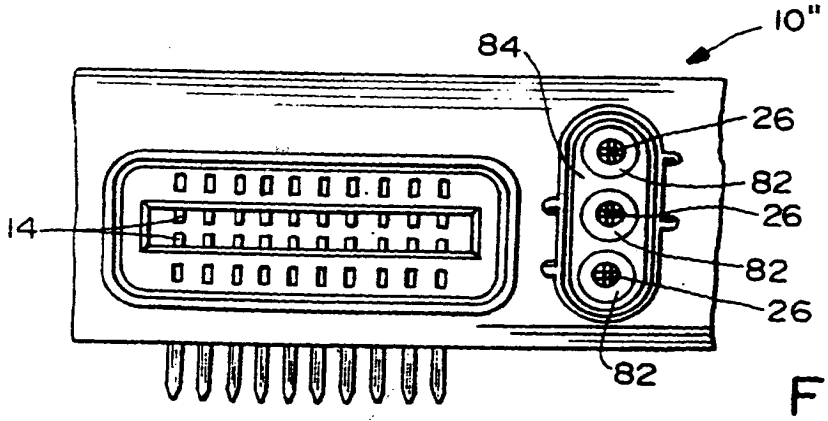


FIG.11

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 10 1101

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	FR-A-1 107 754 (BRITISH INSULATED CALLENDER'S CABLES LTD) * page 3, right column, line 22 - line 38; figure 4 *	1-7	H01R23/68 H01R13/514
A	US-A-4 941 833 (NOSCHESE ET AL.) * abstract; figure 9 *	1	
A	FR-A-542 481 (CAILLAUD) * page 1, line 18 - line 28; figures 3,4 *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	3 March 1995	Horak, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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